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Rosas-Maxemin et al.

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(54) **VEHICLE DETECTION SYSTEMS AND METHODS OF OPERATION THEREOF**

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G08G 1/14 (2006.01)
G07B 15/02 (2011.01)
(Continued)

(52) **U.S. Cl.**
CPC ***G08G 1/144*** (2013.01); ***G01C 21/3461*** (2013.01); ***G05D 1/0088*** (2013.01); ***G05D 1/0225*** (2013.01); ***G05D 1/0242*** (2013.01); ***G05D 1/0255*** (2013.01); ***G06Q 10/00*** (2013.01); ***G06Q 10/02*** (2013.01); ***G07B 15/00*** (2013.01); ***G07B 15/02*** (2013.01); ***G08G 1/146*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC G08G 1/14–1/149; G08G 1/065; G06A 10/02
See application file for complete search history.

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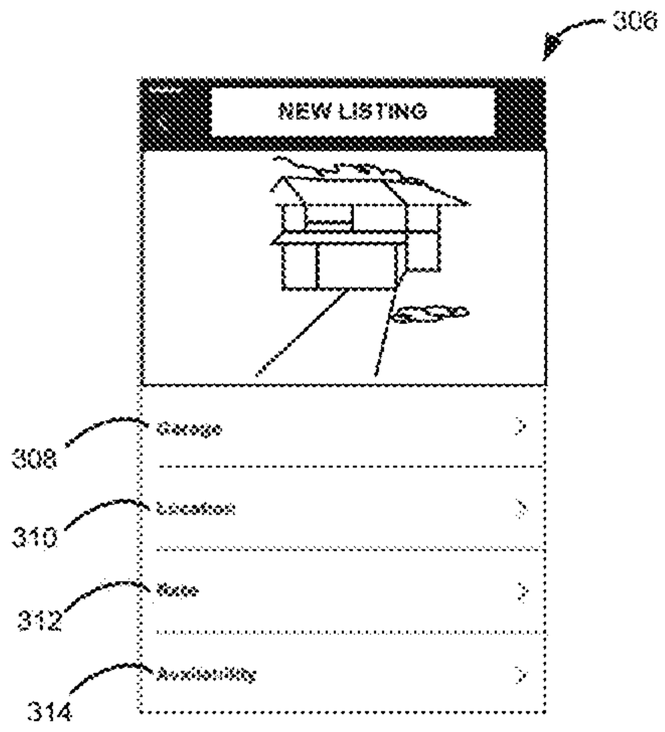
(57) **ABSTRACT**

A parking management system and methods of operation are disclosed. In one variation, a computer-implemented method comprises receiving positional data concerning a listing location from a listing client device; establishing a radius boundary based on the positional data; filtering one or more databases using the radius boundary to determine an amount of parking spaces listed and the amount of parking spaces reserved within a preset time period; calculating a location-specific transaction rate using the amount of parking spaces listed, the amount of parking spaces reserved, and the preset time period; determining a recommended listing price based on the location-specific transaction rate; and transmitting the recommended listing price to the listing client device.

20 Claims, 9 Drawing Sheets



Related U.S. Application Data

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(51) **Int. Cl.**

G06Q 10/00	(2012.01)
G01C 21/34	(2006.01)
G05D 1/00	(2006.01)
G05D 1/02	(2006.01)
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G07B 15/00	(2011.01)
G06F 17/30	(2006.01)

(52) **U.S. Cl.**

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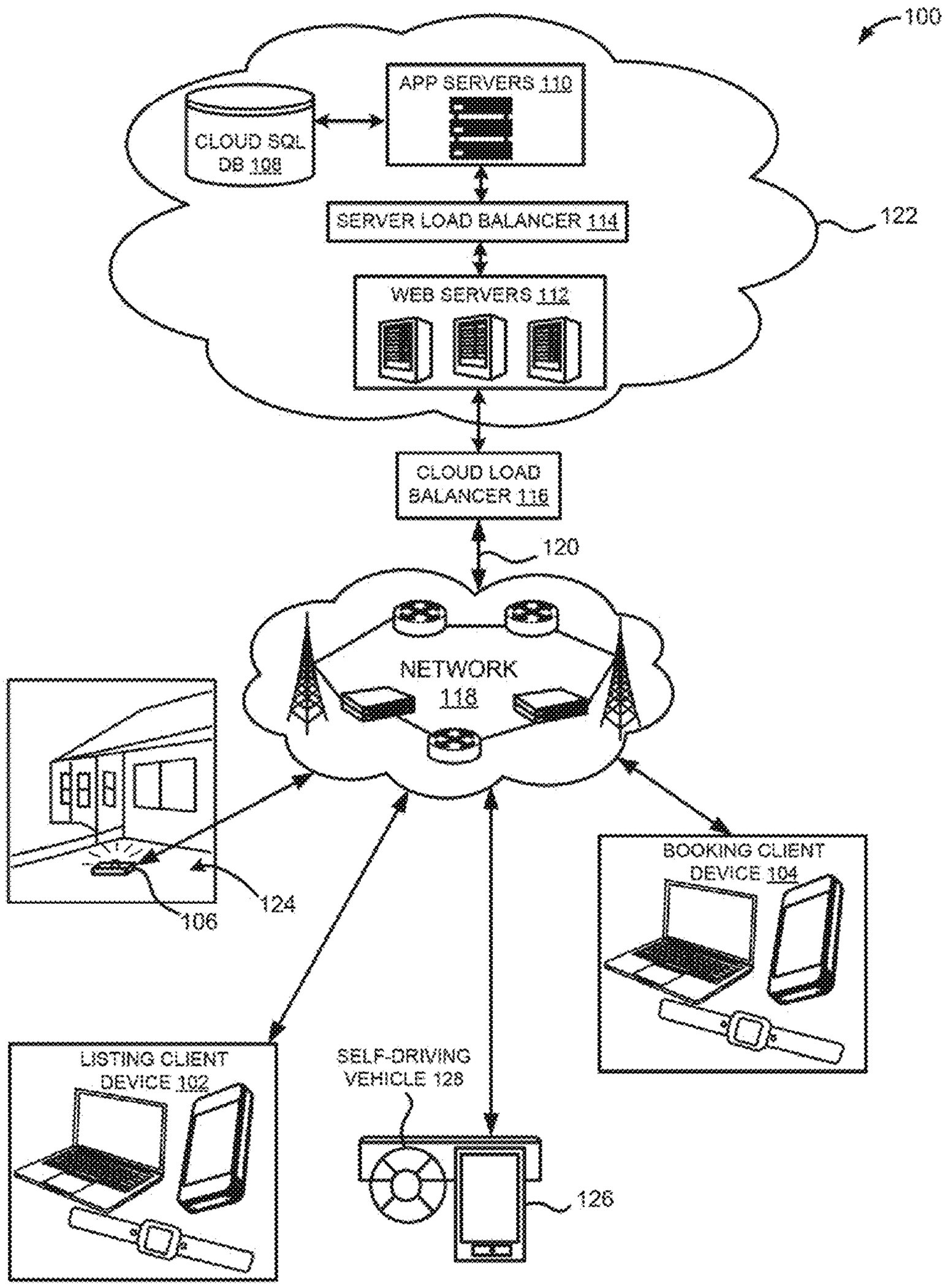
100
APP SERVERS 110
CLOUD SQL DB 108
SERVER LOAD BALANCER 114
122
WEB SERVERS 112
CLOUD LOAD BALANCER 116
120
NETWORK 118
BOOKING CLIENT DEVICE 104
124
106
LISTING CLIENT DEVICE 102
SELF-DRIVING VEHICLE 128
126

FIG. 1

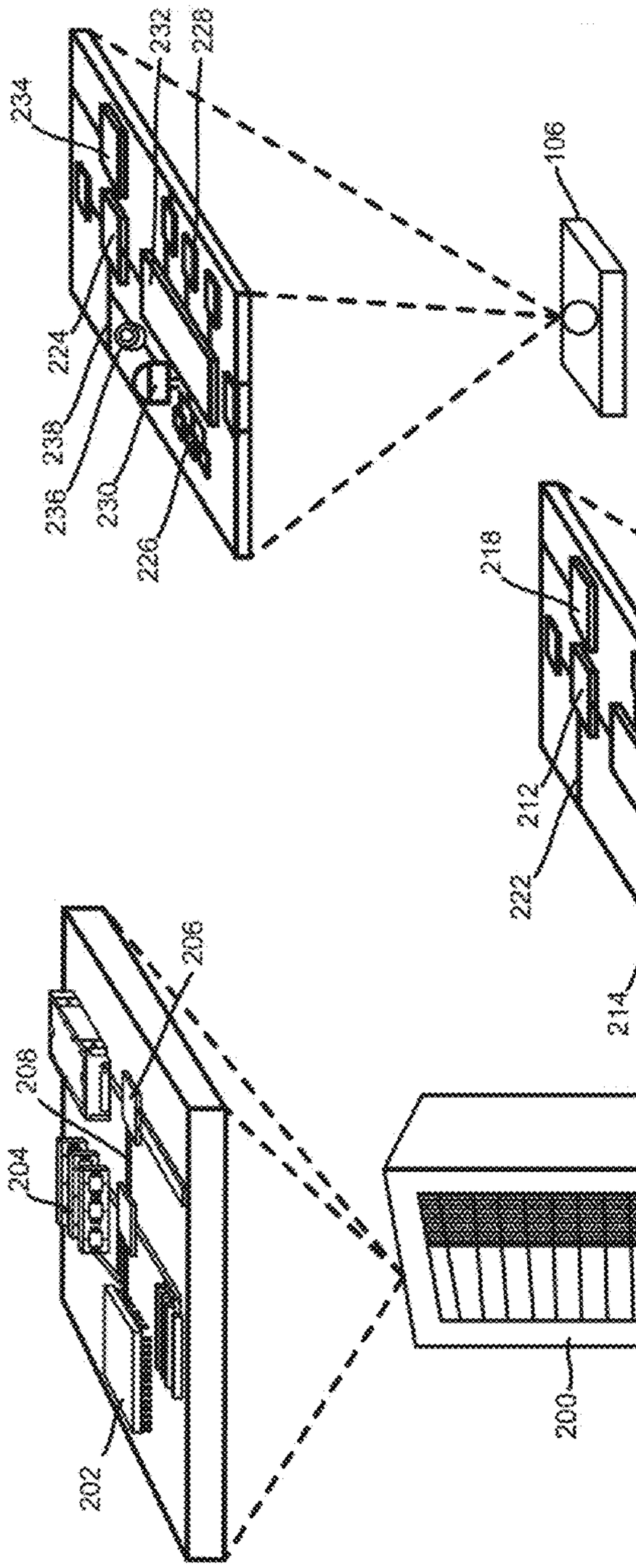

FIG. 2C

FIG. 2B

FIG. 2A

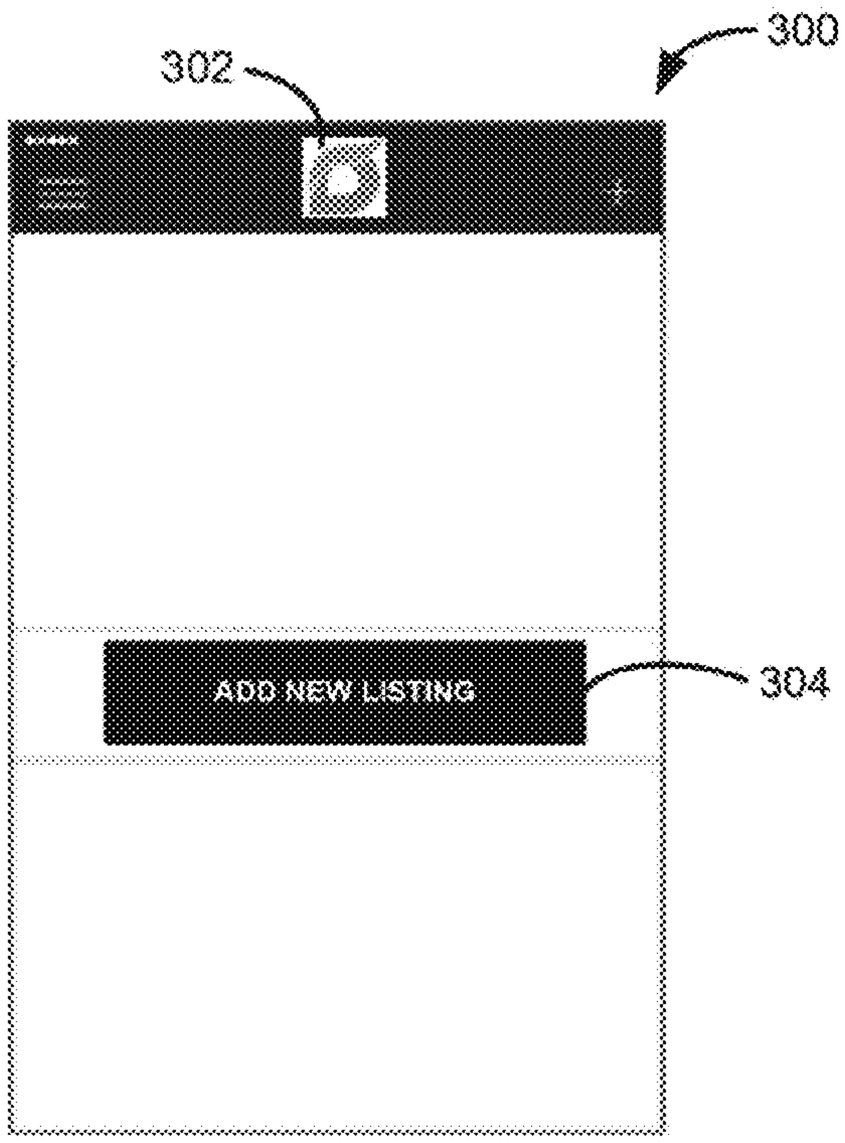
300
302
ADD NEW LISTING
304

FIG. 3A

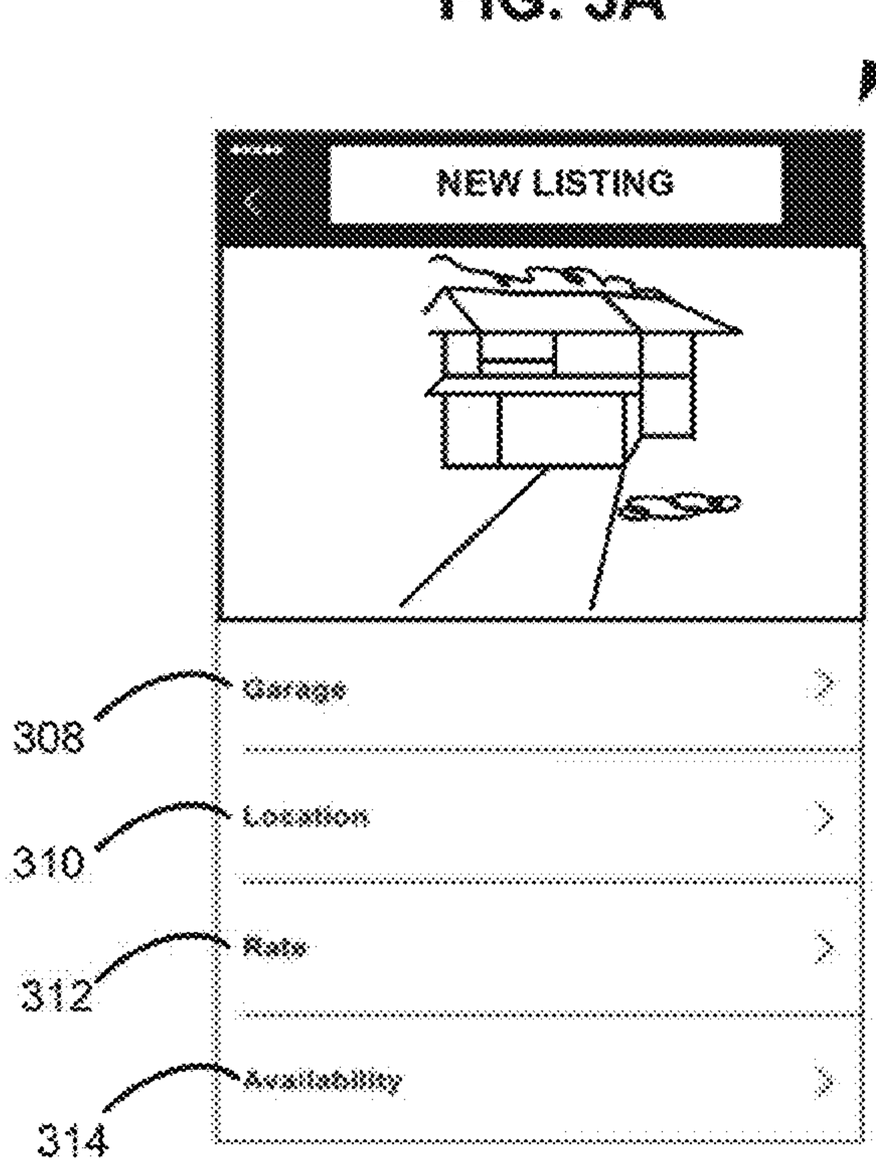
306
NEW LISTING
Garage
Location
Rate
Availability
308
310
312
314

FIG. 3B

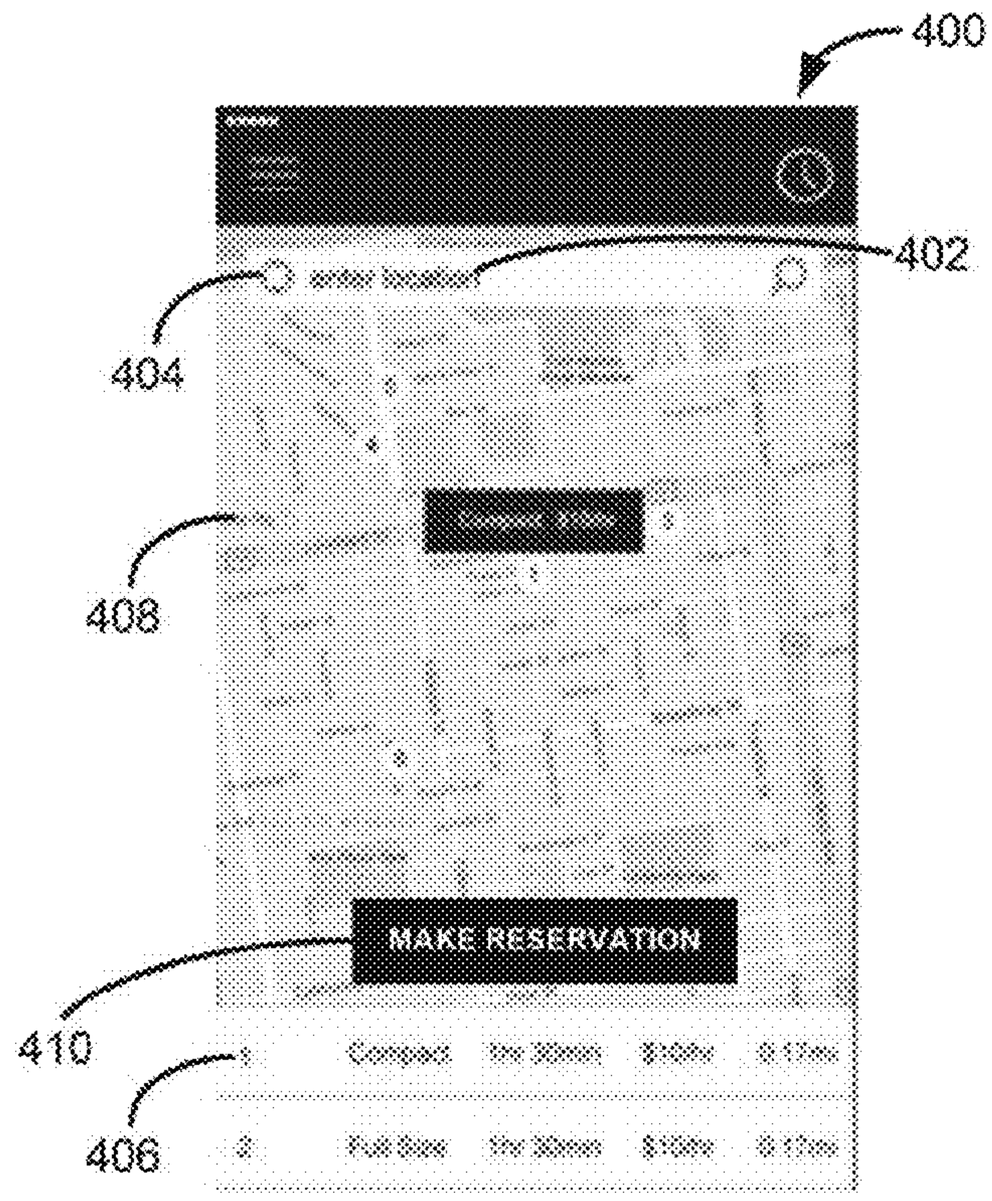
400
402
404
408
MAKE RESERVATION
410
406

FIG. 4A

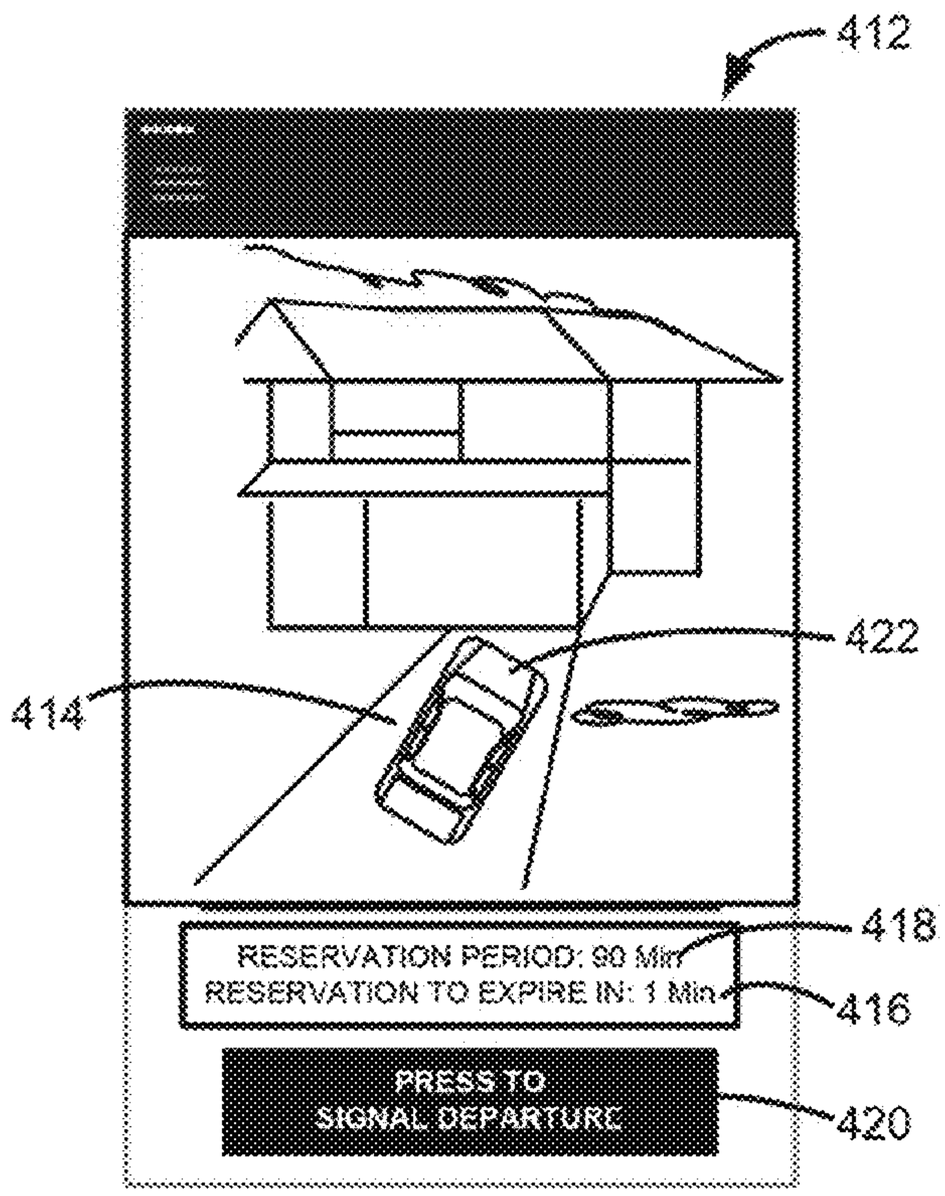
412
422
414
RESERVATION PERIOD: 90 Min
RESERVATION TO EXPIRE IN: 1 Min
418
416
PRESS TO
SIGNAL DEPARTURE
420

FIG. 4B

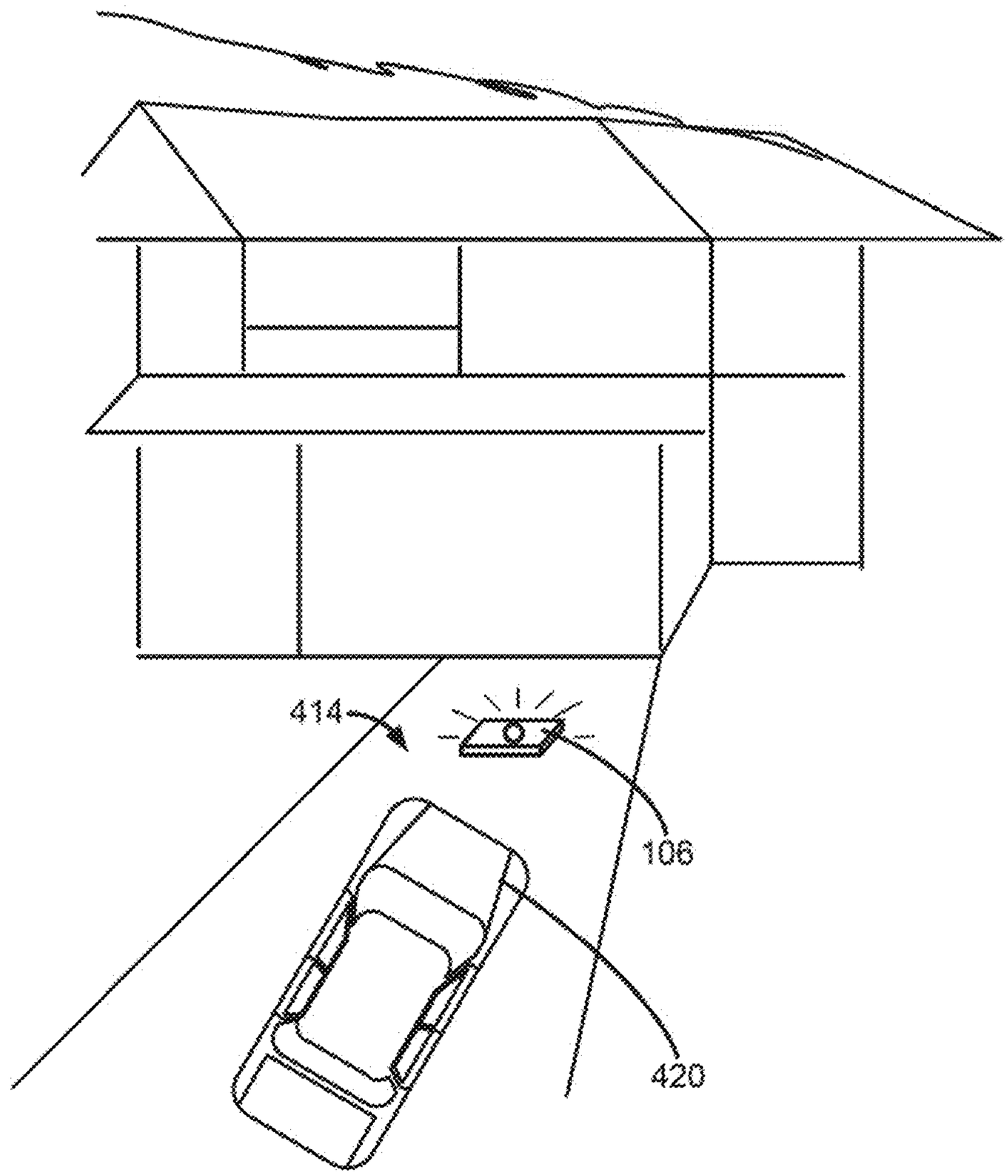

FIG. 5

600

308 602 604 612 312

#	USER ID	TYPE	LAT,LONG/ UTM/GPS	STATUS	REQUEST SOURCE	• • •	LIST TIME	LIST PRICE
001	242345	GRG	37° 4' 31.3" N 122° 2' 38.3" W	RSVD	PARK SENSOR	• • •	'2016-05-09 13:14:07' UTC	$20/hr
002	262345	DWY	(24.2744, -100.405)	AVAIL	MOBILE DEVICE	• • •	'2016-05-09 14:11:05' UTC	$5/hr
003	134516	GRG	19 N 553353.6m E, 423034.6m N	OCCP	PARK SENSOR	• • •	'2016-05-09 12:10:01' UTC	$20/hr
004	538970	DWY	(36.3344, -121.405)	AVAIL	PARK SENSOR	• • •	'2016-05-09 14:15:32' UTC	$18/hr
005	346945	DWY	37° 4' 32.3" N 122° 2' 37.3" W	OCCP	MOBILE DEVICE	• • •	'2016-05-09 12:41:02' UTC	$16/hr
• • •	• • •	• • •	• • •	• • •	• • •		• • •	• • •
999	369712	GRG	(20.2744, -80.405)	AVAIL	PARK SENSOR	• • •	'2016-05-09 12:23:41' UTC	$12/hr

616

FILTER

612

#	USER ID	TYPE	LAT,LONG /UTM/GPS	STATUS	REQUEST SOURCE	• • •	LIST TIME	LIST PRICE
001	242345	DWY	37° 4' 31.3" N 122° 2' 38.3" W	RSVD	PARK SENSOR	• • •	'2016-05-09 13:14:07' UTC	$20/hr
002	125487	GRG	37° 3' 30.3" N 122° 8' 31.3" W	RSVD	PARK SENSOR	• • •	'2016-05-09 13:10:21' UTC	$17/hr
003	346945	DWY	37° 4' 31.3" N 122° 2' 38.3" W	OCCP	MOBILE DEVICE	• • •	'2016-05-09 12:41:02' UTC	$16/hr

616

FIG. 6A

308 602 608 418 606 614 610

#	USER ID	TYPE	LAT,LONG/ UTM/GPS	OCCUP. STATUS	RSV PERIOD	• • •	PARK TIME	BUFFER
001	462311	GRG	37° 4' 31.3" N 122° 2' 38.3" W	EMPTY	1 HR	• • •	IN: N/A OUT: N/A	0.5 HR
002	111567	DWY	37° 2' 24.3" N 122° 9' 30.3" W	EMPTY	2 HR	• • •	IN: N/A OUT: N/A	1 HR
003	302942	DWY	37° 4' 31.3" N 122° 2' 38.3" W	OCCP	1.5 HR	• • •	IN: '2016-05-09 12:55:08' UTC OUT: N/A	0.75 HR

618

612

FIG. 6B

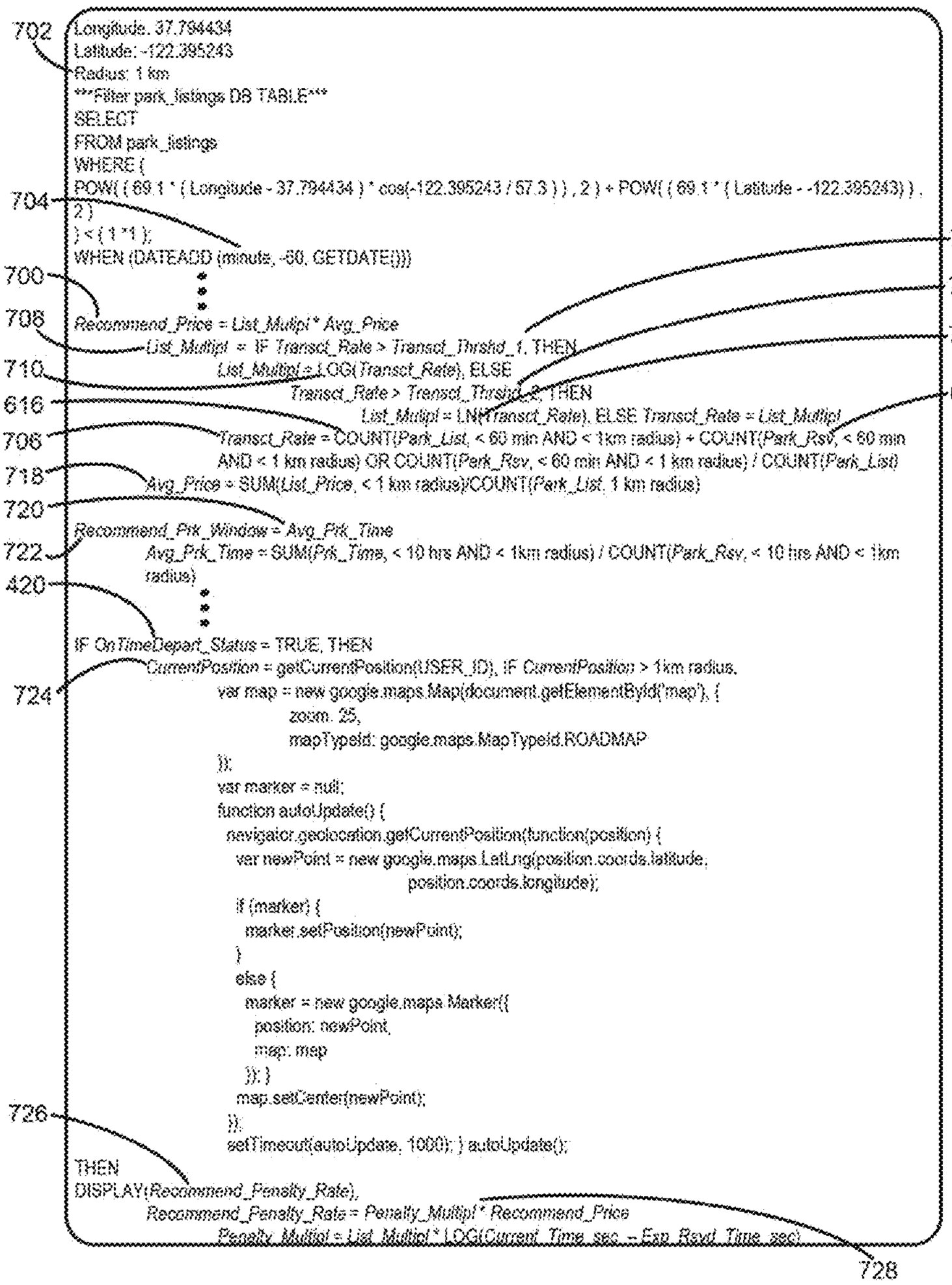
Longitude: 37.794434
Latitude: -122.395243
Radius: 1 km
Filter park_listings DB TABLE
SELECT
FROM park_listings
WHERE (
POW((69.1 * (Longitude - 37.794434) * cos(-122.395243 / 57.3)) , 2) + POW((69.1 * (Latitude - -122.395243)) , 2)
) < (1 *1);
WHEN (DATEADD (minute, -60, GETDATE()))
Recommend_Price = List_Multipl * Avg_Price
List_Multipl = IF Transct_Rate > Transct_Thrshd_1, THEN
List_Multipl = LOG(Transct_Rate), ELSE
Transct_Rate > Transct_Thrshd_2, THEN
List_Multipl = LN(Transct_Rate), ELSE Transct_Rate = List_Multipl
Transct_Rate = COUNT(Park_List, < 60 min AND < 1km radius) + COUNT(Park_Rsv, < 60 min AND < 1 km radius) OR COUNT(Park_Rsv, < 60 min AND < 1 km radius) / COUNT(Park_List)
Avg_Price = SUM(List_Price, < 1 km radius)/COUNT(Park_List, 1 km radius)
Recommend_Prk_Window = Avg_Prk_Time
Avg_Prk_Time = SUM(Prk_Time, < 10 hrs AND < 1km radius) / COUNT(Park_Rsv, < 10 hrs AND < 1km radius)
IF OnTimeDepart_Status = TRUE, THEN
CurrentPosition = getCurrentPosition(USER_ID), IF CurrentPosition > 1km radius,
var map = new google.maps.Map(document.getElementById('map'), {
zoom: 25,
mapTypeId: google.maps.MapTypeId.ROADMAP
});
var marker = null;
function autoUpdate() {
navigator.geolocation.getCurrentPosition(function(position) {
var newPoint = new google.maps.LatLng(position.coords.latitude,
position.coords.longitude);
if (marker) {
marker.setPosition(newPoint);
}
else {
marker = new google.maps.Marker({
position: newPoint,
map: map
}); }
map.setCenter(newPoint);
});
setTimeout(autoUpdate, 1000); } autoUpdate();
THEN
DISPLAY(Recommend_Penalty_Rate),
Recommend_Penalty_Rate = Penalty_Multipl * Recommend_Price
Penalty_Multipl = List_Multipl * LOG(Current_Time_sec - Exp_Revd_Time_sec)
702
704
700
708
710
616
706
718
720
722
420
724
726
712
716
714
618
728

FIG. 7

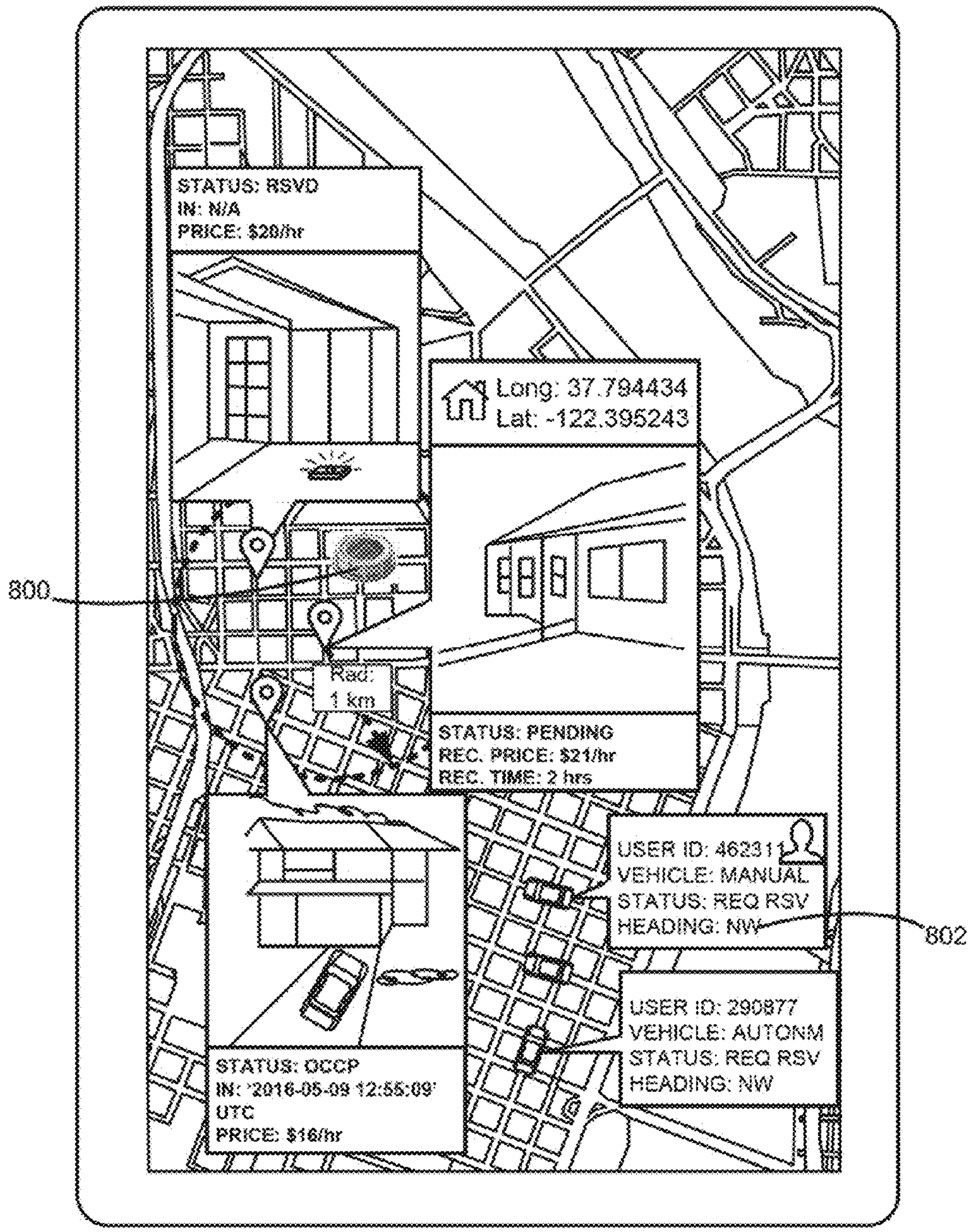
STATUS: RSVD
IN: N/A
PRICE: $20/hr
Long: 37.794434
Lat: -122.395243
800
Rad:
1 km
STATUS: PENDING
REC. PRICE: $21/hr
REC. TIME: 2 hrs
USER ID: 46231
VEHICLE: MANUAL
STATUS: REQ RSV
HEADING: NW
802
USER ID: 290877
VEHICLE: AUTONM
STATUS: REQ RSV
HEADING: NW
STATUS: OCCP
IN: '2016-05-09 12:55:09'
UTC
PRICE: $16/hr

FIG. 8

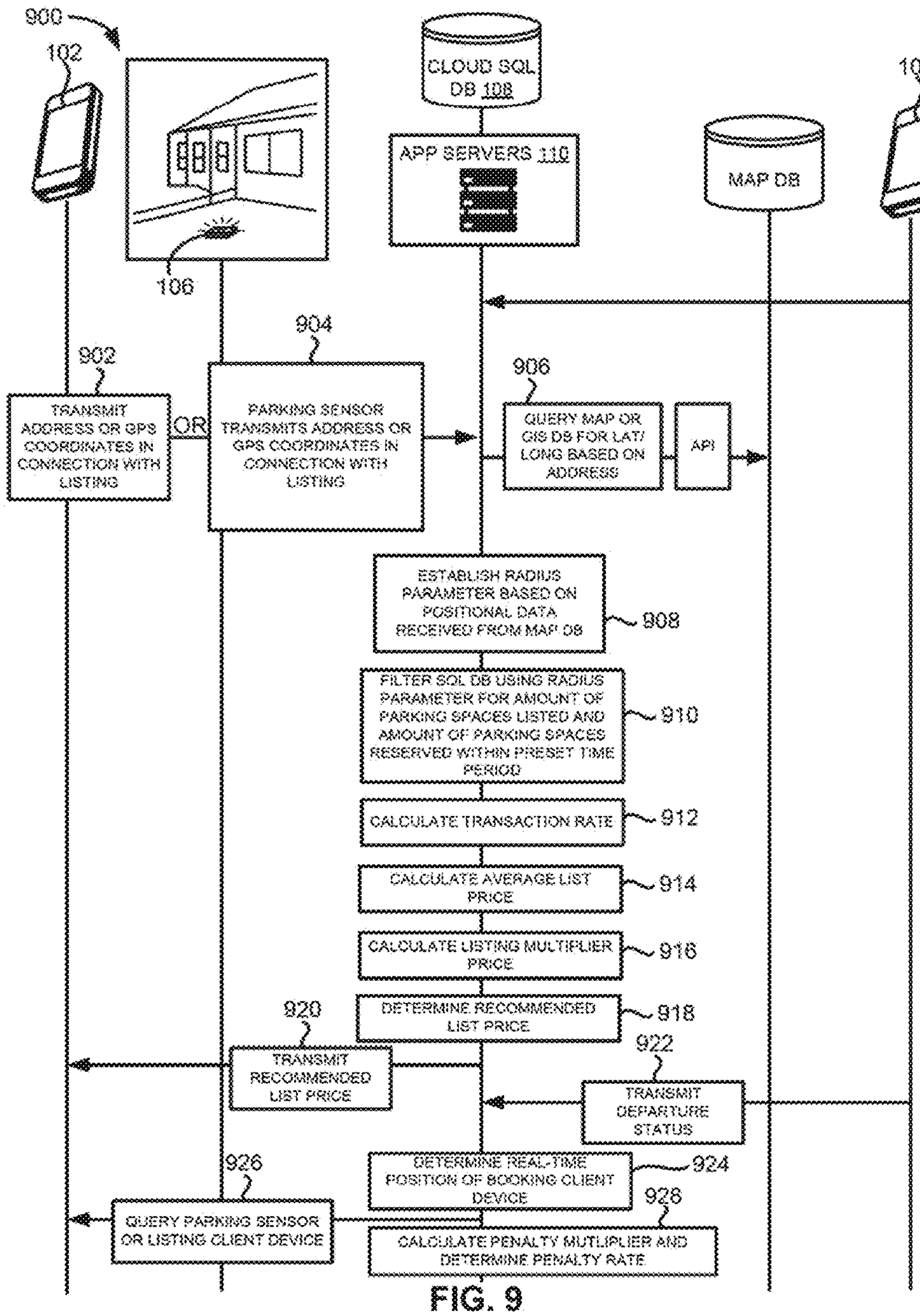
900
102
106
CLOUD SQL DB 108
APP SERVERS 110
MAP DB
104
902
TRANSMIT ADDRESS OR GPS COORDINATES IN CONNECTION WITH LISTING
OR
904
PARKING SENSOR TRANSMITS ADDRESS OR GPS COORDINATES IN CONNECTION WITH LISTING
906
QUERY MAP OR GIS DB FOR LAT/LONG BASED ON ADDRESS
API
ESTABLISH RADIUS PARAMETER BASED ON POSITIONAL DATA RECEIVED FROM MAP DB
908
FILTER SQL DB USING RADIUS PARAMETER FOR AMOUNT OF PARKING SPACES LISTED AND AMOUNT OF PARKING SPACES RESERVED WITHIN PRESET TIME PERIOD
910
CALCULATE TRANSACTION RATE
912
CALCULATE AVERAGE LIST PRICE
914
CALCULATE LISTING MULTIPLIER PRICE
916
DETERMINE RECOMMENDED LIST PRICE
918
920
TRANSMIT RECOMMENDED LIST PRICE
922
TRANSMIT DEPARTURE STATUS
DETERMINE REAL-TIME POSITION OF BOOKING CLIENT DEVICE
924
926
QUERY PARKING SENSOR OR LISTING CLIENT DEVICE
928
CALCULATE PENALTY MUTLIPLIER AND DETERMINE PENALTY RATE

FIG. 9

VEHICLE DETECTION SYSTEMS AND METHODS OF OPERATION THEREOF

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application is a continuation of PCT application no. PCT/US16/32529, filed on May 13, 2016, which claims the benefit of U.S. Provisional Application No. 62/162,574, filed on May 15, 2015. The above-identified patent applications are hereby incorporated by reference in their entireties.

TECHNICAL FIELD

This disclosure relates generally to the field of vehicle parking management and, more specifically, to vehicle detection systems and methods of operation thereof.

BACKGROUND

Parking a vehicle in densely populated environments is often a frustrating experience due to the dearth of free parking spaces and the expense of private parking garages or lots. This is especially true in populated urban environments such as the downtowns of large municipalities (e.g., New York City, San Francisco, etc.). Moreover, parking is often in demand near destinations or event venues such as neighborhoods surrounding sports stadiums, concert halls, amusement parks, or beachfronts.

Additionally, the high price of real estate has motivated many property owners to seek out non-traditional ways for property owners to monetize their real property assets. For example, homeowners can often rent out rooms in their homes to tourists or travelers using an online home rental platform.

Therefore, a solution is needed for a parking management system to conveniently, securely and effectively allow property owners to rent out their available parking space(s) and for drivers seeking parking to reserve such parking spaces. In addition, such a solution should assist the property owner in determining an appropriate rental price for their parking spaces. Also, such a solution should be able to assist the property owner in maximizing their earning potential from such assets by ensuring adequate turnover in parked vehicles and that empty parking spaces are occupied quickly and efficiently. Moreover, such a solution should also ensure that drivers vacate rented parking spaces in time so as not to inconvenience property owners who require such spaces and suggest appropriate penalty measures when drivers overstay their allotted parking times.

SUMMARY

A parking management system and methods of operation are disclosed. A computer-implemented method of managing parking reservations over a communications network can include receiving, in one or more databases stored in one or more memory units, positional data concerning a listing location. The method can also include establishing, using one or more processors of a computing system, a radius boundary based on the positional data stored in the one or more databases and filtering, using the one or more processors, the one or more databases using the radius boundary to determine an amount of parking spaces listed and the amount of parking spaces reserved within a preset time period. The method can also include calculating, using the one or more processors, a transaction rate using the amount of parking spaces listed, the amount of parking spaces reserved, and the preset time period and storing the transaction rate in the one or more databases. The method can also include determining, using the one or more processors, a recommended listing price based on the transaction rate and transmitting, over the communications network using one or more communication interfaces, the recommended listing price to a listing client device.

The method can also include receiving, over the communications network, one or more listing requests from one or more parking sensors. The method can also include receiving, over the communications network, one or more reservation requests from at least one of one or more booking client devices and one or more control units of a self-driving vehicle and updating, using the one or more processors, the amount of parking spaces listed and the amount of parking spaces reserved in the one or more databases using the one or more listing requests and the one or more reservation requests.

The one or more parking sensors can include a proximity detector, one or more sensor processors, a sensor communication interface, and a portable power supply. The one or more parking sensors can also include a positioning unit of a booking client device or the control unit of a self-driving vehicle.

The method can also include adding, using the one or more processors, a buffer period to a reservation period in response to receiving the reservation request from at least one of the booking client device and the control unit of the self-driving vehicle. The method can also include calculating, using the one or more processors, an average listing price based on listing prices stored in the one or more databases prior to determining the recommended listing price and determining, using the one or more processors, the recommended list price by calculating a listing multiplier using the transaction rate stored in the one or more databases and multiplying the listing multiplier by the average listing price.

The method can also include calculating the listing multiplier by applying, using the one or more processors, a logarithmic function to the transaction rate stored in the one or more databases when the transaction rate exceeds a rate threshold. The method can also include receiving timestamp data from one or more sensors in a vicinity of the listing location and storing the timestamp data in the one or more databases. The method can also include determining, using the one or more processors, an average park time using the timestamp data; and transmitting, over the communications network using the one or more communication interfaces, a recommended availability time calculated using the average park time to the listing client device. The one or more sensors can include a positioning unit of at least one of one or more booking client devices and one or more control units of a self-driving vehicle.

The method can also include receiving, over the communications network, a status update from a booking client device concerning an upcoming departure of a vehicle occupying a reserved parking space. The method can also include determining a real-time position of the booking client device in response to receiving the status update and querying a parking sensor in a vicinity of the reserved parking space in response to the status update received from the booking client device to confirm an occupancy status of the reserved parking space.

The method can also include calculating a penalty multiplier using the transaction rate based on the occupancy

status of the reserved parking, calculating a penalty rate using the penalty multiplier and a listing price, and transmitting, over the communications network, the penalty rate to at least one of the booking client device and the listing client device.

A computing system to manage parking reservations over a communications network can include one or more communication interfaces, one or more memory units, one or more processors executing computer-readable instructions stored in the one or more memory units to receive, in one or more databases stored in the one or more memory units, positional data concerning a listing location, establish a radius boundary based on the positional data stored in the one or more databases, and filter the one or more databases using the radius boundary to determine an amount of parking spaces listed and the amount of parking spaces reserved within a preset time period.

The computing system can also calculate a transaction rate using the amount of parking spaces listed, the amount of parking spaces reserved, and the preset time period and storing the transaction rate in the one or more databases, determine a recommended listing price based on the transaction rate, and transmit, over the communications network using the one or more communication interfaces, the recommended listing price to a listing client device.

A non-transitory computer readable medium can include computer executable instructions stored thereon executed by one or more processors, where the instructions include the steps of receiving, in one or more databases stored in one or more memory units, positional data concerning a listing location, establishing, using the one or more processors of a computing system, a radius boundary based on the positional data stored in the one or more databases, and filtering, using the one or more processors, the one or more databases using the radius boundary to determine an amount of parking spaces listed and the amount of parking spaces reserved within a preset time period. The instructions can also include the steps of calculating, using the one or more processors, a transaction rate using the amount of parking spaces listed, the amount of parking spaces reserved, and the preset time period and storing the transaction rate in the one or more databases, determining, using the one or more processors, a recommended listing price based on the transaction rate, and transmitting, over the communications network using one or more communication interfaces, the recommended listing price to a listing client device.

The methods, devices, or systems disclosed herein may be implemented in a variety of different ways. Certain variations have other steps or elements in addition to or in place of those mentioned above. The steps or elements will become apparent to those skilled in the art from the accompanying drawings or from the detailed description that follows.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates a parking management system.

FIG. **2**A illustrates a variation of a server of the parking management system.

FIG. **2**B illustrates a variation of a client device of the parking management system.

FIG. **2**C illustrates a variation of a parking sensor of the parking management system.

FIG. **3**A illustrates a new listing graphical user interface (GUI) displayed on a listing client device connected to the parking management system.

FIG. **3**B illustrates a listing information GUI displayed on a listing client device connected to the parking management system.

FIG. **4**A illustrates a reservation request GUI displayed on a booking client device connected to the parking management system.

FIG. **4**B illustrates a reservation status GUI displayed on a booking client device connected to the parking management system.

FIG. **5** illustrates a schematic of a booking vehicle detected by a parking sensor at a listing location.

FIG. **6**A illustrates a variation of a listing database table stored in one or more databases of the parking management system.

FIG. **6**B illustrates a variation of a reservation database table stored in one or more databases of the parking management system.

FIG. **7** illustrates examples of computer readable instructions and application logic undertaken by the parking management system.

FIG. **8** illustrates a variation of a map overview GUI displayed on a display component connected to the parking management system.

FIG. **9** illustrates a method of operation of the parking management system.

DETAILED DESCRIPTION OF THE INVENTION

FIG. **1** illustrates that a parking management system **100** can include one or more listing client devices **102**, booking client devices **104**, parking sensors **106**, or a combination thereof communicatively coupled to one or more databases **108**, application servers **110**, web servers **112**, server load balancers **114**, cloud load balancers **116**, or a combination thereof over a communications network **118**.

The communications network **118** can be any multi-hop network that covers regions, countries, continents, or a combination thereof. Examples of the communications network **118** can include a cellular network such as a 3G network, a 4G network, a long-term evolution (LTE) network; a sonic communication network; a satellite network; a wide area network such as the Internet, or a combination thereof. The web servers **112**, the application servers **110**, the server load balancers **114**, the cloud load balancers **116**, or a combination thereof can be communicatively coupled to the communications network **118** through connections **120**. The connections **120** can be wired connections, wireless connections, or a combination thereof.

The parking management system **100**, or a portion therein, can include a web and/or mobile application hosted by a computing cloud **122** such as a Windows Azure™ cloud, an Amazon Elastic Computer Cloud (Amazon EC2)™, a Google App Engine™, or a combination thereof. For example, the parking management system **100** can include a web and/or mobile application run on virtual machines hosted on the one or more application servers **110**, web servers **112**, or a combination thereof. In one variation, the computing cloud **122** can include the one or more application servers **110**, web servers **112**, databases **108**, server load balancers **114**, cloud load balancers, portions therein, or a combination thereof. The parking management system **100** can rely on processing and storage resources provided by the one or more application servers **110**, web servers **112**, databases **108**, server load balancers **114**, cloud load balancers **116**, or a combination thereof.

The cloud load balancers **116** can provide traffic load balancing and distribute client requests among multiple web servers **112**. The web servers **112** can include HTTP servers or rely on the computing cloud **122** to handle HTTP requests. The web servers **112** can also be instantiated and managed by the computing cloud **122**.

The server load balancer **114** can balance interactions between the web servers **112** and the one or more application servers **110**. The application servers **110** can handle application logic and interacts with the databases **108** to store data and application states. The web servers **112**, the application servers **110**, or a combination thereof can include rack mount servers, cluster servers, blade servers, main frames, dedicated desktops or laptops, or a combination thereof.

The databases **108** can be one or more SQL databases. The application servers **110** can interface with one or more SQL servers managing the SQL databases. The application data and application states can be stored in a cloud managed SQL database. In other variations, the database **108** can be a document-oriented database including a NoSQL database such as a MongoDB® database.

The application servers **110**, the web servers **112**, the cloud load balancers **116**, the server load balancers **114**, and the cloud SQL databases **108** can be any of the servers, load balancers, and databases discussed in U.S. Pat. No. 9,176,773, the content of which is hereby incorporated by reference in its entirety.

The listing client devices **102**, the booking client devices **104**, or a combination thereof can include a portable computing device such as a smartphone, a tablet, a laptop, a smartwatch, a personal entertainment device, or a combination thereof. In other variations, the listing client device **102**, the booking client device **104**, or a combination thereof can include a desktop computer. The listing client device **102** can be used by a user of the parking management system **100** to list a parking space for rental or lease by other users of the parking management system **100**. The booking client device **104** can be used by a user of the parking management system **100** to book a parking space listed for rental or lease on the parking management system **100**.

The parking management system **100** can also include one or more parking sensors **106**. The parking sensors **106** can be located at a listing location **124**. In one variation, the parking sensor **106** can include the sensing components shown in FIG. **2**C. In other variations, the parking sensor **106** can refer to a client device such as the listing client device **102**, the booking client device **104**, or parts therein.

The parking management system **100** can be communicatively coupled to a control unit **126** of a self-driving vehicle **128**. For example, the parking management system **100** can receive data or client requests from the control unit **126** of the self-driving vehicle **128**. The self-driving vehicle **128** can include motor vehicles or vessels having an autonomous or semiautonomous driving mode. For example, the self-driving vehicle **128** can be vehicles disclosed or discussed in U.S. Pat. No. 9,120,485, U.S. Pat. No. 8,965,621, and U.S. Pat. No. 8,954,217, the contents of which are hereby incorporated by reference in their entireties.

FIG. **2**A illustrates that a server **200** of the parking management system **100** can have one or more processors **202**, a memory **204**, and a communication interface **206**. The processors **202** can be coupled to the memory **204** and the communication interface **206** through high-speed buses **208**. The server **200** can represent any of the web servers **112**, the application servers **110**, or a combination thereof of FIG. **1**.

The processors **202** can include one or more central processing units (CPUs), graphical processing units (GPUs), Application-Specific Integrated Circuits (ASICs), field-programmable gate arrays (FPGAs), or a combination thereof. The processors **202** can execute software or computer-readable instructions stored in the memory **204** to execute the methods or operations described herein. The processors **202** can be implemented in a number of different manners. For example, the processors **202** can include one or more embedded processors, processor cores, microprocessors, logic circuits, hardware finite state machines (FSMs), digital signal processors (DSPs), or a combination thereof. For example, the processors **202** can be 64-bit processors.

The memory **204** can store software, data, logs, or a combination thereof. The memory **204** can be an internal memory. Alternatively, the memory **204** can be an external memory, such as a memory residing on a storage node, a cloud server, or a storage server. The memory **204** can be a volatile memory or a non-volatile memory. For example, the memory **204** can be a nonvolatile storage such as non-volatile random access memory (NVRAM), Flash memory, disk storage, or a volatile storage such as static random access memory (SRAM). The memory **204** can be the main storage unit for the server **200**.

The communication interface **206** can include one or more wired or wireless communication interfaces. For example, the communication interface **206** can be a network interface card of the server **200**. The communication interface **206** can be a wireless modem or a wired modem. In one variation, the communication interface **206** can be a WiFi modem. In other variations, the communication interface **206** can be a 3G modem, a 4G modem, an LTE modem, a Bluetooth® component, a radio receiver, an antenna, or a combination thereof. The server **200** can connect to or communicatively couple with the communications network **118** using the communication interface **206**. The server **200** can transmit or receive packets or messages using the communication interface **206**.

FIG. **2**B illustrates that a client device **210** of the parking management system **100** can have a client processor **212**, a client memory **214**, a client communication unit **216**, a locational unit **218** having a global positioning system (GPS) receiver, and a display **220**. The client processor **212** can be coupled to the client memory **214**, the client communication unit **216**, and the locational unit **218** through high-speed buses **222**.

The client processor **212** can include one or more CPUs, GPUs, ASICs, FPGAs, or a combination thereof. The client processor **212** can execute software stored in the client memory **214** to execute the methods described herein. The client processor **212** can be implemented in a number of different manners. For example, the client processor **212** can be an embedded processor, a processor core, a microprocessor, a logic circuit, a hardware FSM, a DSP, or a combination thereof. As a more specific example the client processor **212** can be a 32-bit processor such as an ARM® processor.

The client memory **214** can store software, data, logs, or a combination thereof. In one variation, the client memory **214** can be an internal memory. In another variation, the client memory **214** can be an external storage unit. The client memory **214** can be a volatile memory or a non-volatile memory. For example, the client memory **214** can be a nonvolatile storage such as NVRAM, Flash memory, disk storage, or a volatile storage such as SRAM. The client memory **214** can be the main storage unit for the client device **210**.

The client communication unit **216** can be a wired or wireless communication interface. For example, the client

communication unit **216** can be a network interface card of the client device **210**. The client communication unit **216** can be a wireless modem or a wired modem. In one variation, the client communication unit **216** can be a WiFi modem. In other variations, the client communication unit **216** can be a 3G modem, a 4G modem, an LTE modem, a Bluetooth® component, a radio receiver, an antenna, or a combination thereof. The client device **210** can connect to or communicatively couple with the communications network **118** using the client communication unit **216**. The client device **210** can transmit or receive packets or messages using the client communication unit **216**.

The locational unit **218** can include a GPS component such as the GPS receiver, an inertial unit, a magnetometer, a compass, or a combination thereof. The locational unit **218** can receive GPS signals from a GPS satellite. The inertial unit can be implemented as a multi-axis accelerometer including a three-axis accelerometer, a multi-axis gyroscope including a three-axis MEMS gyroscope, or a combination thereof.

The display **220** can be a touchscreen display such as a liquid crystal display (LCD), a thin film transistor (TFT) display, an organic light-emitting diode (OLED) display, or an active-matrix organic light-emitting diode (AMOLED) display. In certain variations, the display **220** can be a retina display, a haptic touchscreen, or a combination thereof. For example, when the client device **210** is a smartphone, the display **220** can be the touchscreen display of the smartphone.

The client device **210** can refer to any of the listing client device **102**, the booking client device **104**, or a combination thereof. For purposes of the present disclosure, the client processor **212** can refer to a processor of the listing client device **102**, the booking client device **104**, or a combination thereof. Moreover, the client memory **214** can refer to a memory of the listing client device **102**, the booking client device **104**, or a combination thereof. In addition, the client communication unit **216** can refer to a communication unit of the listing client device **102**, the booking client device **104**, or a combination thereof. Furthermore, the locational unit **218** can refer to a locational unit or GPS receiver of the listing client device **102**, the booking client device **104**, or a combination thereof. Additionally, the display **220** can refer to the display of the listing client device **102**, the booking client device **104**, or a combination thereof.

For example, the servers **200** and client devices **210** disclosed herein can include the type of computing systems and mobile computing devices disclosed or discussed in U.S. Pat. No. 9,305,310, the content of which is hereby incorporated by reference in its entirety.

FIG. **2**C illustrates that the parking sensor **106** can include a sensor processor **224**, a sensor memory **226**, a sensor communication interface **228**, a proximity detector **230**, a portable power supply **232**, or a combination thereof. In other variations, the parking sensor **106** can include a sensor locational unit **234** having a global positioning system (GPS) receiver, a camera unit **236**, or a combination thereof. The sensor processor **224** can be coupled to the sensor memory **214**, the sensor communication interface **228**, the proximity detector **230**, the portable power supply **232**, or a combination thereof through high-speed buses **222**.

The sensor processor **224** can include one or more CPUs, GPUs, ASICs, FPGAs, or a combination thereof. The sensor processor **224** can execute software stored in the sensor memory **226** to execute the methods or operations described herein. The sensor processor **224** can be implemented in a number of different manners. For example, the sensor processor **224** can include a processor core, a microprocessor, a logic circuit, a DSP, or a combination thereof. As a more specific example the sensor processor **224** can include a 16-bit or 32-bit processor such as an ARM™ processor.

The sensor memory **226** can store software, data, logs, or a combination thereof. In one variation, the sensor memory **226** can be an internal memory. In another variation, the sensor memory **226** can be an external storage unit. The sensor memory **226** can be a volatile memory or a nonvolatile memory. For example, the sensor memory **226** can be a nonvolatile storage such as NVRAM, Flash memory, disk storage, or a volatile storage such as SRAM.

The sensor communication interface **228** can be a wired or wireless communication interface. For example, the sensor communication interface **228** can be a network interface card of the parking sensor **106**. The sensor communication interface **228** can be a wireless modem or a wired modem. In one variation, the sensor communication interface **228** can be a WiFi modem. In other variations, the sensor communication interface **228** can be a 3G modem, a 4G modem, an LTE modem, a Bluetooth® component, a radio receiver, an antenna, or a combination thereof. The parking sensor **106** can connect to or communicatively couple with the communications network **118** using the sensor communication interface **228**. The parking sensor **106** can transmit or receive information or messages in the form of data packets using the sensor communication interface **228**.

The proximity detector **230** can include an infrared (IR) light transceiver, an IR distance sensor, an ultrasonic transmitter and detector, or a combination thereof. The parking sensor **106** can use the proximity detector **230** to detect the presence of a vehicle in a certain vicinity of the parking sensor **106**. For example, the parking sensor **106** can detect that a vehicle is near the parking sensor **106** when a portion of the vehicle, such as the chassis of the vehicle, covers or obscures the proximity detector **230** or a portion therein. In another variation, the parking sensor **106** can detect the presence of a vehicle when a part of the vehicle affects or interferes with a behavior of light or acoustic waves emitted, reflected, or received by the parking sensor **106**.

The sensor locational unit **234** can include a GPS component such as a GPS receiver, an inertial unit, a magnetometer, a compass, or a combination thereof. The sensor locational unit **234** can receive GPS signals from a GPS satellite. The inertial unit can be implemented as a multi-axis accelerometer including a three-axis accelerometer, a multi-axis gyroscope including a three-axis MEMS gyroscope, or a combination thereof. The parking sensor **106** can also include a camera unit **236**. The camera unit **236** can capture static images, video images, or a combination thereof and store the images in the sensor memory **226**.

The sensor processor **224** can be coupled to the sensor memory **226**, the sensor communication interface **228**, the sensor locational unit **234**, the proximity detector **230**, and the camera unit **236** through high-speed buses **238**.

FIG. **3**A illustrates that a listing user of the parking management system **100** can list a parking space for rent or lease by applying a user input to a new listing graphical user interface (GUI) **300** displayed on a listing client device **102**. The listing user can list the parking space by applying a user input to a button or link displayed as part of the new listing GUI **300**. The listing user can transmit a listing request **304** to the application servers **110** in response to applying the user input to the button or link.

The listing request **304** can be transmitted as one or more communication packets, such as transmission control protocol (TCP) packets, containing a header and a payload. The

listing request **304** can be received by the web servers **112**, the application servers **110**, or a combination thereof and stored in the database **108**.

The new listing GUI **300** can be rendered through an application **302**. In one variation, the application **302** can be written using the Xcode™ programming language, the Swift™ programming language, or a combination thereof. In other variations, the application **302** can be written using the Java™ programming language, the Objective-C programming language, or a C programming language.

FIG. **3**B illustrates that the listing user can input information concerning the parking space through a listing information GUI **306**. The listing user can enter a type **308** of parking space, a listing location **310**, a listing price **312**, an availability window **314**, or a combination thereof. The type **308** of parking space can include a driveway space, a parking space in a residential or commercial garage, a parking space in a parking lot, a front yard or back yard space, a curb space, a metered space, or a combination thereof.

The listing location **310** can include an address of a residence, building, or other location providing the parking space. The listing user can manually enter a geographic address for the listing location **310** through the listing information GUI **306**. In this case, the application server **110** can transmit the geographic address to a map database, such as a Geographic Information System (GIS) database or a Google Maps® database and query the map database for positional coordinates corresponding to the geographic address. The application server **110** can then store the positional coordinates in the database **108**. In another variation, the user can use the locational unit **218** of the listing client device **102** to provide positional coordinates for the listing location **310** when the user is at the listing location **310**.

The listing price **312** can include an hourly rate or price requested by the user for the parking space. The availability window **314** can be a time window when the parking space is available for rent or lease. For example, the availability window **314** can range from 30 minutes to 30 days. The listing request **304** can include data concerning the type **308** of parking space, the listing location **310**, the listing price **312**, the availability window **314**, or a combination thereof.

In other variations, the listing request **304** can be transmitted directly from the parking sensor **106**. The parking sensor **106** can automatically transmit the listing request **304** to the application servers **110** when the parking sensor **106** detects a vehicle has departed a parking space in the vicinity of the parking sensor **106**. For example, the parking sensor **106** can be configured to store information concerning the listing location **310**, the listing price **312**, the availability window **314**, and the type **308** of listing in the sensor memory **226**. The parking sensor **106** can automatically transmit a listing request **304** containing such data or information as soon as the space is vacant. As a more specific example, the parking sensor **106** can be a sensor embedded in a driveway of a residence and the parking sensor **106** can transmit the listing request **304** as soon as a vehicle previously occupying the driveway vacates the driveway.

FIG. **4**A illustrates that a booking user of the parking management system **100** can reserve a parking space listed by a listing user through a reservation request GUI **400**. The booking user can reserve a parking space in a desired booking location **402** by manually entering a geographic address. In addition, the booking user can apply an input to a current location icon **404** displayed on the reservation request GUI **400** to prompt the locational unit **218** of the booking client device **104** to transmit the current geographic coordinates of the booking client device **104** to the application servers **110**, the cloud-managed database **108**, or a combination thereof. Moreover, the booking user can draw a radius boundary around a portion of a map graphic **408** displayed on the reservation request GUI **400**.

The reservation request GUI **400** can display parking space listings **406** in list form or overlaid on the map graphic **408**. Each space listings **406** can include information concerning the listing location **310**, the listing price **312**, or the availability window **314** associated with the space listing **406**. Once the booking user has found a desired parking space, the booking user can select the space listing **406** to place a reservation request **410**. For example, the booking user can apply a user input to an icon associated with the space listing **406** and then press a reservation button to place the reservation request **410**.

FIG. **4**B illustrates that the booking user can view a current status of a reserved parking space **414** once a reservation has been placed using the parking management system **100**. The booking user can view the current status of the reservation through a reservation status GUI **412**. The reservation status GUI **412** can include a timer **416** counting down a reservation period **418**. In other variations, the reservation status GUI **412** can display an accrued cost of the reservation. The booking user can apply a user input to a departure button to transmit a status update **420** to the parking management system **100** that a booking vehicle **422** is either in the process of departing the reserved parking space **414** or has departed the reserved parking space **414**.

In another variation, the booking client device **104** can receive one or more messages or notifications from the parking management system **100** concerning the expiration of the reservation period **418**. For example, the messages can include a text messages, such as a Short Message Service (SMS) message, a Multimedia Messaging Service (MMS) message, or a combination thereof. The messages can include a link to prompt the booking client device **104** to open the application **302** and display the reservation status GUI **412**. The link can be a deep linking uniform resource locator (URL) address directing the booking client device **104** to open a specific page of the application **302**.

In other variations, the booking vehicle **422** can be a self-driving vehicle **128** and the control unit **126** of the self-driving vehicle **128** can automatically transmit the reservation request **410** without input from the booking user. The reservation request **410** can include preset information or data concerning the parking space desired by an occupant or owner of the self-driving vehicle **128** including a listing location **310**, the listing price **312**, the type **308** of listing, or a combination thereof. The parking management system **100** can receive the reservation request **410** directly from the control unit **126** of the self-driving vehicle **128** and parse the reservation request **410** for data or information concerning the listing location **310**, the listing price **312**, the type **308** of listing, or a combination thereof. The parking management system **100** can then filter the one or more databases **108** to select a listing **406** matching the criteria included in the reservation request **410**.

The parking management system **100** can also receive the status update **420** directly from the control unit **126** of the self-driving vehicle **128** without input from the booking user. The status update **420** can indicate that the self-driving vehicle **128** is departing or has departed the reserved parking space **414**.

The listing client device **102**, the booking client device **104**, the parking sensors **106**, or a combination thereof can

encrypt requests, including a listing request **304** or a reservation request **410**, before transmitting the request. The listing client device **102**, the booking client device **104**, the parking sensors **106**, or a combination thereof can encrypt the requests using an encryption protocol such as a secure hash algorithm (SHA). The encryption protocol can be a SHA-256 hash function, a SHA-384 hash function, or any type of SHA-2 certificate or function. The listing client device **102**, the booking client device **104**, the parking sensors **106**, or a combination thereof can securely transmit the encrypted request over the communications network **118** to servers or other devices in the computing cloud **122**.

FIG. **5** illustrates that the parking management system **100** can query a parking sensor **106** in a vicinity of the reserved parking space **414** in response to the status update **420** received from the booking client device **104** to confirm an occupancy status of the booking vehicle **422**. For example, the application server **110** can ping the parking sensor **106** and request the last proximity measurement from the sensor memory **226**. The application server **100** can also ping the parking sensor **106** to activate the proximity detector **230** of the parking sensor **106** and query the parking sensor **106** for a real-time proximity measurement.

In another variation, the parking management system **100** can activate the camera unit **236** of the parking sensor **106** and instruct the camera unit **236** to capture images of the environment surrounding the reserved parking space **414**. The parking sensor **106** can then transmit the images to the one or more application servers **110** for analysis by an image recognition protocol executed by the one or more processors **202**.

In variations where the parking sensor **106** refers to a listing client device **102** or portions therein, the application servers **110** can transmit one or more messages to the listing client device **102** to confirm that the booking vehicle **422** has departed the reserved parking space **414**.

FIG. **6**A illustrates that the database **108** can store in one or more database tables **600** positional data **602** concerning a listing location **310**. The one or more databases **108** can include a cloud managed SQL database such as Microsoft Azure® database. The one or more databases **108** can be stored in a memory **204** of the computing cloud **122**.

One or more servers responsible for managing the database **108** can receive the positional data **602** from a map database, such as a Google Maps® database, after querying the map database with a geographic address received from the booking client device **104**. In other variations, the web servers **112**, the application servers **110**, or a combination thereof can receive the positional data **602** directly from the locational unit **218** of the booking client device **104**.

The positional data **602** can include latitudinal and longitudinal coordinates. For example, the positional data **602** can include latitude and longitude coordinates in the Universal Traverse Mercator (UTM) coordinate system.

The database **108** can store the positional data **602** concerning the listing location **310** in one or more listing database tables **604**. The application servers **110** can also parse the listing request **304** received from the booking client device **104**, the control unit **126** of the self-driving vehicle **128**, or a combination thereof and store data or information concerning the type **308** of parking space, the listing price **312**, the availability window **314**, or a combination thereof in the listing database tables **604**.

FIG. **6**B illustrates that the database **108** can also include one or more reservation database tables **606**. The reservation database tables **606** can include data or information obtained from the reservation request **410** including the type **308** of parking space, the reservation period **418**, positional data **602** concerning the reserved parking space **414**, or a combination thereof. The reservation database tables **606** can also include data or information concerning an occupancy status **608** of the reserved parking space **414**, a buffer period **610**, and/or an actual parking time **614** based on timestamps **612** received from the listing client device **102** or the parking sensors **106**.

The parking management system **100** can determine the occupancy status **608** of a reserved parking space **414** by querying or pinging one or more parking sensors **106** in a vicinity of the reserved parking space **414**. In another variation, the parking management system **100** can determine the occupancy status **608** of a reserved parking space **414** by receiving a confirmation signal or message from a listing client device **102**. For example, the parking management system **100** can transmit a text message to the listing client device **102** containing a link directing the listing user to confirm that a booking vehicle **422** has vacated the reserved parking space **414**.

The parking management system **100** can also add a buffer period **610** to the reservation period **418** of a reservation request **410** stored in the reservation database tables **606**. The parking management system **100** can set the buffer period **610** based on the length of the reservation period **418**. For example, the parking management system **100** can set the buffer period **610** as half the length of the reservation period **418** initially requested by a booking user. In another variation, the parking management system **100** can automatically set a buffer period **610** of one hour for all reservations exceeding 30 minutes.

The parking management system **100** can permit the booking user to extend the reservation period **418** up to the end of the buffer period **610**. For example, when a booking user initially requests a reservation period **418** of one hour, the parking management system **100** can automatically set the buffer period **610** for this reservation as 30 minutes. In this case, the parking management system **100** can allow the booking user to park the user's vehicle in the reserved parking space **414** for up to 1.5 hours. The parking management system **100** can charge the booking user an additional fee for the extension. Upon reaching the end of the buffer period **610**, the parking management system **100** can prevent the booking user from extending the reservation period **418** any longer and require the booking user to initiate a new reservation request **410**.

When a buffer period **610** is added to a reservation period **418**, the parking management system **100** can ensure the listing **406** does not appear as an entry in any database tables listing available or unoccupied parking spaces during the pendency of the reservation period **418** and the buffer period **610**. The parking management system **100** can add a buffer period **610** to all reservation requests **410** received from booking client devices **104** and/or the control units **126** of all self-driving vehicles **128**.

The databases **108** can also store timestamps **612** received from listing client devices **102**, booking client devices **104**, parking sensors **106**, or a combination thereof. The listing client devices **102**, the parking sensors **106**, or a combination thereof can transmit timestamps **612** in connection with the transmission of listing requests **304**. The booking client devices **104** can transmit timestamps **612** in connection with the transmission of reservation requests **410**. The parking sensors **106**, the listing client devices **102**, or a combination thereof can also transmit timestamps **612** in connection with the transmission of status updates **420** or when the occupancy status **608** of a reserved parking space **414** changes.

The reservation database table **606** can also store actual parking times **614** based on the timestamps **612** received. The parking management system **100** can determine the actual parking times **614** based on timestamps **612** received when a booking vehicle **422** occupies the reserved parking space **414** and the same booking vehicle **422** vacates the reserved parking space **414**. The actual parking times **614** can differ from the reservation periods **418** included in the reservation requests **410**.

The database tables **600** can also keep track of a listing count **616** and a reservation count **618**. The listing count **616** can correspond to the number or amount of parking spaces listed using the parking management system **100** during a given time period. The reservation count **618** can correspond to the number or amount of parking spaces reserved using the parking management system **100** during a given time period. For example, the listing count **616** can correspond to the number of listing requests **304** received by the parking management system **100** within a given time period. The reservation count **618** can correspond to the number of reservation requests **410** received by the parking management system **100** within a given time period. The parking management system **100** can continuously update the one or more database tables **600**, including the listing count **616** and the reservation count **618**, based on the number of listing requests **304** and the number of reservation requests **410** received.

FIG. **7** illustrates that one or more processors **202** of the parking management system **100** can execute computer-readable instructions stored in a memory **204** of the computing cloud **122** in order to determine a recommended list price **700**. The parking management system **100** can determine the recommended list price **700** in response to a listing request **304** received from a listing client device **102**.

The parking management system **100** can determine the recommended list price **700** by first establishing a radius boundary **702** based on the positional data **602** received from the listing client device **102**. The parking management system **100** can retrieve the positional data **602** stored in the one or more databases **108** and establish the radius boundary **702** using the coordinates of the position data **602** as the center point. For example, the parking management system **100** can establish the radius boundary **702** as the boundary or demarcation of a one mile or one kilometer radius. The parking management system **100** can set the size of the radius boundary **702** based on a geographic criterion such as a size of the municipality or geographic region in which the positional data **602** is located. The parking management system **100** can also adjust the radius boundary **702** based on a time-of-day, a day-of-the-week, a month, a season, or a combination thereof.

The parking management system **100** can then filter the one or more databases **108** using the radius boundary **702** and a preset time period **704**. The preset time period **704** can range from 10 minutes to 10 days. In other variations, the preset time period **704** can be more than 10 days. The preset time period **704** can be adjusted by an administrator of the parking management system **100**. The parking management system **100** can filter the one or more listing database tables **604** using the radius boundary **702** and the positional data **602** of all other listing requests **304** received within the preset time period **704** to determine the listing count **616**. The parking management system **100** can also filter the one or more reservation database tables **606** using the radius boundary **702** and the positional data **602** of all reservation requests **410** received within the preset time period **704** to determine the reservation count **618**.

The parking management system **100** can then calculate a transaction rate **706** using the listing count **616** and the reservation count **618**. The transaction rate **706** can be calculated by summing the listing count **616** and the reservation count **618**. The transaction rate **706** can be calculated by summing the listing count **616** and the reservation count **618** to yield a total count and then dividing the total count by the preset time period **704**. The transaction rate **706** can also be equivalent to either the reservation count **618** or the listing count **616**. The parking management system **100** can store the transaction rate **706** in one or more database tables **600** and update the transaction rate **706** as new listing requests **304** are received.

The transaction rate **706** can also be calculated by taking a ratio of the reservation count **618** and the listing count **616** and or by dividing the reservation count **618** by the listing count **616**. The parking management system **100** can also calculate the transaction rate **706** by adding the ratio of the reservation count **618** and the listing count **616** to any of the listing count **616**, the reservation count **618**, or a sum thereof.

The parking management system **100** can then calculate a listing multiplier **708** using the transaction rate **706**. The parking management system **100** can calculate the listing multiplier **708** by applying a first logarithmic function **710** to the transaction rate **706** when the transaction rate **706** exceeds a first rate threshold **712**. For example, the first rate threshold **712** can be a rate of 10 listings and/or requests per minute and the parking management system **100** can apply a $\log_{10}$ function to the transaction rate **706** when the transaction rate **706** exceeds the first rate threshold **712**. When the transaction rate **706** does not exceed the first rate threshold **712**, the parking management system **100** can apply a second logarithmic function **714** to the transaction rate **706** when the transaction rate **706** exceeds a second rate threshold **716**. The first rate threshold **712** can be different from the second rate threshold **716**. For example, the first rate threshold **712** can be greater than the second rate threshold **716**. The second logarithmic function **714** can be a natural log function.

The parking management system **100** can determine the recommended listing price **700** by multiplying the listing multiplier **708** by an average listing price **718**. The parking management system **100** can calculate the average listing price **718** by taking an average of the listing prices **312** stored in the filtered instance of the listing database tables **604**. After calculating the recommended listing price **700**, the application servers **110** can transmit the recommended listing price **700** to the listing client device **102** over the communications network **118**.

The parking management system **100** can also determine an average park time **720** based on the actual parking times **614** stored in the filtered instance of the reservation database table **606**. The parking management system **100** can then transmit a recommended availability time **724** to the listing client device **102** equivalent to the average park time **720**. In other variations, the parking management system **100** can multiply the average park time **720** by a multiplier to yield the recommended availability time **724**.

The parking management system **100** can also ensure a booking user does not abuse the system by occupying a reserved parking space **414** past the end of the reservation period **418**. The parking management system **100** can receive, over the communications network **118**, a status update **420** concerning a departure or upcoming departure of a booking vehicle **422** from a reserved parking space **414**.

The parking management system **100** can determine a real-time position of the booking client device **104** associated with the booking vehicle **422** in response to receiving the status update **420**. The parking management system **100** can determine a real-time position **724** of the booking client device **104** by querying a map database such as a Google Maps® database. In another variation, the parking management system **100** can determine a real-time position **724** of the booking client device **104** by directly tracking a locational unit **218** of the booking client device **104**.

When the real-time position **724** of the booking client device **104** is not in a vicinity of the listing location **310** of the reserved parking space **414**, such as when the booking client device **104** is outside the radius boundary **702**, the parking management system **100** can query the parking sensor **106** in the vicinity of the reserved parking space **414** to confirm the occupancy status **608** of the reserved parking space **414**. In another variation, the parking management system **100** can query the listing client device **102** to confirm the occupancy status **608** of the reserved parking space **414** by requesting the listing user enter a user input to confirm the departure of the booking vehicle **422**. In other variations, when the booking vehicle **422** is a self-driving vehicle **128**, the parking management system **100** can ping the control unit **126** of the self-driving vehicle **128** for a real-time position of the self-driving vehicle **128**.

The parking management system **100** can calculate a penalty rate **726** using a penalty multiplier **728**. In one variation, the penalty multiplier **728** can be equivalent to the listing multiplier **708**. In other variations, the penalty multiplier **728** can be greater than the listing multiplier **708**, such as double the value of the listing multiplier **708**. The parking management system **100** can calculate the penalty rate **726** by multiplying the listing price **312** by the penalty multiplier **728**. The parking management system **100** can transmit, over the communications network **118**, the penalty rate **726** to the booking client device **104**, the listing client device **102**, or a combination thereof.

FIG. **8** illustrates that the parking management system **100** can determine a causal point-of-interest (POI) **800** using the transaction rate **706** and positional data **602** included in the listing requests **304** and reservation requests **410** received by the parking management system **100** within a preset time period **704**. The parking management system **100** can determine the causal POI **800** when the transaction rate **706** within a certain radius boundary **702** exceeds a rate threshold such as five or ten listings and/or requests per minute. The radius boundary **702** can be established when the parking management system **100** receives the first listing request **304** or reservation request **410**.

The causal POI **800** can be a location or venue causing a surge or sudden increase in demand for parking within a vicinity of the causal POI **800**. For example, the causal POI **800** can include a sports stadium, a concert hall, a nightclub, a movie theater, a museum, or a restaurant. The causal POI **800** can also include a location of an event such as a site of a farmer's market, a political gathering, or a parade route.

The parking management system **100** can determine the causal POI **800** by calculating a centroid of a polygon created by the positional coordinates of listing requests **304** or reservation requests **410** received within a preset time period **704**. For example, three reservation requests **410** can be received within a 60 second period and the parking management system **100** can calculate the centroid of a triangle having vertices at the three desired booking locations **402** included in the three reservation requests **410**.

The parking management system **100** can also determine the causal POI **800** using a request trajectory **802**. The request trajectory **802** can be the trajectory or direction of travel of a vehicle or other mode of transportation carrying a booking client device **104**. In other variations, the request trajectory **802** can be the trajectory or direction of travel of a self-driving vehicle **128** transmitting a reservation request **410**.

When the parking management system **100** determines the location of the causal POI **800**, the parking management system **100** can send one or more notifications, messages, or alerts to user client devices in the vicinity of the causal POI **800** to alert such users to list their parking spaces using the parking management system **100**. The parking management system **100** can send notifications, messages, or alerts to client devices of users who have previously listed their parking spaces using the parking management system **100**. The parking management system **100** can also send notifications, messages, or alerts to user client devices along the request trajectory **802** or along a route leading to the causal POI **800**.

FIG. **9** illustrates that a computer-implemented method **900** of managing parking reservations over the communications network **118** can include receiving, in one or more databases **108** stored in one or more memory units **204**, positional data **602** concerning a listing location **310**. The positional data **602** or address of the listing location **310** can be transmitted by a listing client device **102** in step **902**. The positional data **602** or address of the listing location **310** can also be transmitted by a parking sensor **106** in step **904**. When the listing client device **102** or parking sensor **106** transmits an address, the application servers **110** can query a map or GIS database for the positional coordinates of the address in step **906**. The application servers **110** can interact with the map or GIS database through a map API such as the Google Maps® API.

The method **900** can also include establishing, using one or more processors **202**, a radius boundary **702** based on the positional data **602** stored in the one or more databases **108** in step **908**. The method **900** can also include filtering, using the one or more processors **202**, the one or more databases **108** using the radius boundary **702** to determine the listing count **616** representing an amount of parking spaces listed and the reservation count **618** representing the amount of parking spaces reserved within a preset time period **704** in step **910**.

The method **900** can also include calculating, using the one or more processors **108**, a transaction rate **706** using the listing count **616**, the reservation count **618**, and the preset time period **704** and storing the transaction rate **706** in the one or more databases **108** in step **912**. The method **900** can also include calculating an average listing price **718** in step **914**. The method **900** can also include calculating a listing multiplier **708** in step **916**. The method **900** can include determining, using the one or more processors **108**, a recommended listing price **700** based on the average listing price **718** and the listing multiplier **708**. The method **900** can include transmitting the recommended listing price **700** to the listing client device **102** over the communications network **118** in step **920**.

The method **900** can also include the application servers **110** receiving a status update **420** concerning the departure of a booking vehicle **422** from a reserved parking space **414**. For example, a booking client device **104** can transmit the status update **420** in step **922**. The method **900** can include determining a real-time position **724** of the booking client device **104** in response to receiving the status update **420** in

step **924**. The method **900** can also include querying a parking sensor **106** in the vicinity of the reserved parking space **414** in response to the status update to confirm an occupancy status **608** of the reserved parking space **414** in step **926**. The method **900** can also include calculating a penalty rate **726** using a penalty multiplier **728** when the system determines the booking vehicle **422** has overstayed the end of the reservation period **418** in step **928**.

The system and methods described herein provides an improvement in the way parking data or information is managed and stored in a cloud managed database. In addition, by calculating a recommended listing price **700** based on a transaction rate **706** corresponding to the rate at which parking listings are added and reservation requests are received, the system provides an improvement in the field of parking management beyond recommending prices based on static inventory levels.

A number of variations have been described. Nevertheless, it will be understood by one of ordinary skill in the art that various modifications may be made without departing from the spirit and scope of the variations. In addition, the flowcharts or logic flows depicted in the figures do not require the particular order shown, or sequential order, to achieve desirable results. In addition, other steps or operations may be provided, or steps or operations may be eliminated, from the described flows, and other components may be added to, or removed from, the described systems. Accordingly, other variations are within the scope of the following claims.

It will be understood by one of ordinary skill in the art that the various methods disclosed herein may be embodied in a non-transitory readable medium, machine-readable medium, and/or a machine accessible medium comprising instructions compatible, readable, and/or executable by a processor or processing unit of a machine, device, or computing device. The structures and modules in the figures may be shown as distinct and communicating with only a few specific structures and not others. The structures may be merged with each other, may perform overlapping functions, and may communicate with other structures not shown to be connected in the figures. Accordingly, the specification and/or drawings may be regarded in an illustrative rather than a restrictive sense.

What is claimed is:

1. A system, comprising:

a non-transitory memory; and

one or more processors coupled to the non-transitory memory and configured to execute instructions to perform operations comprising:

receiving, from a first user device, a search request including location data of the first user device and search request parameters;

filtering, using the one or more processors, in response to the search request, one or more databases to determine listing locations within a reservation region that match the search request parameters, the reservation region being based on the location data;

providing a notification to respective listing user devices in response to determined parking spaces within the reservation region being below a first threshold;

automatically selecting a first listing location based on determined listing locations that match the search request parameters, including:

a proximity to a physical location of the first user device;

determined occupancy statuses of the listing locations; and

dimensions associated with the respective listing locations; and

transmitting instructions to the first user device directing the first user device to the first listing location.

2. The system of claim **1**, wherein the operations further comprise:

determining an occupancy status change of the first listing location; and

requesting an updated status data set responsive to determining the occupancy status change.

3. The system of claim **1**, wherein the operations further comprise:

obtaining location data sets from a plurality of user devices associated with a group of user devices; and

determining, based on the location data sets, that the group of user devices are travelling to a destination within a predefined proximity to a second plurality of listing locations.

4. The system of claim **1**, wherein the operations further comprise transmitting requests to second user devices to promote second users to list one or more second listing locations as available for occupation.

5. The system of claim **1**, wherein the operations further comprise:

receiving, from a first user device, a departure notification from a first parking location;

determining, by a first parking sensor, an occupancy status of the first parking location; and

updating in one or more databases coupled to the one or more processors an amount of available parking spaces.

6. The system of claim **1**, wherein the first user device includes a self-driving vehicle and the operations further comprise causing the self-driving vehicle to proceed to the first listing location using the instructions.

7. The system of claim **1**, wherein the operations further comprise obtaining, from a plurality of object detection sensors, status data sets associated with the listing locations, the plurality of object detection sensors including one or more sensors selected from a group consisting of an Infra-Red (IR) light transceiver, an IR distance sensor, an ultrasonic detector, and an imaging sensor.

8. The system of claim **1**, wherein the operations further comprise activating one or more cameras associated with the first listing location to capture one or more images of the first listing location.

9. The system of claim **1**, wherein the operations further comprise:

determining an event location is associated with a geographical region based on determining a number of search requests for listing locations exceeds a first second threshold; and

providing a notification to respective listing user devices along a route leading to the event location.

10. The system of claim **1**, wherein the operations further comprise:

obtaining, from a plurality of object detection sensors, status data sets associated with the listing locations, each of the plurality of object detection sensors including a proximity detector, one or more sensor processors, a sensor communication interface, and a portable power supply.

11. A computer-implemented method, the method comprising:

receiving, on a network interface device, a search request including positional data of a first user device and search request parameters;

filtering, using one or more processors, in response to the search request, one or more databases to determine parking spaces within a reservation region that match the search request parameters, the reservation region being based on the positional data;

providing a notification to respective listing user devices in response to determined parking spaces within the reservation region being below a first threshold;

in response to determining parking spaces within the reservation region that match the search request parameters, automatically selecting a first parking space of the determined parking spaces based on:

a proximity of the first parking space;

a determined occupancy status of the first parking space; and

dimensions of the first parking space; and

transmitting instructions to the first user device directing the first user device to the first parking space.

12. The computer-implemented method of claim **11**, wherein the determined occupancy status of the first parking space is determined by querying a parking sensor in a vicinity of the first parking space.

13. The computer-implemented method of claim **12**, further comprising capturing, by a camera unit of the parking sensor, one or more images of a parking space area of the first parking space.

14. The computer-implemented method of claim **12**, wherein querying a parking sensor is performed in response to receiving a status update from the first user device.

15. The computer-implemented method of claim **11**, further comprising:

determining an event location is associated with a first geographical region based on determining a number of search requests of a plurality of search requests for the plurality of listing locations exceeds a second threshold; and

providing a notification to respective listing user devices along a route leading to the event location.

16. The computer-implemented method of claim **11**, further comprising:

calculating a listing multiplier in response to the number of the search requests of the plurality of the search requests for the plurality of listing locations exceeding the first a second threshold; and

providing a second notification including the listing multiplier to the respective listing user devices associated with the plurality of listing locations.

17. The computer-implemented method of claim **11**, further comprising:

calculating a penalty multiplier in response to determining a vehicle associated with the first user device has overstayed a reservation period.

18. A non-transitory computer readable medium comprising computer executable instructions stored thereon, which, when executed by one or more processors, cause the one or more processors to perform a method, comprising:

determining an event location based on search requests from a plurality of user devices within a first geographical region exceeding a first threshold number of search requests, the search requests including positional data and search request parameters;

receiving, on a network interface device, route information from a first user device including destination coordinates;

determining the destination coordinates are within the first geographical region;

receiving a first search request from the first user device including positional data of the first user device and first search request parameters;

identifying a location of the first user device based on the positional data;

automatically selecting a first parking space within the first geographical region based on the search request parameters; and

transmitting instructions causing the first user device to be directed to the first user device to the first parking space.

19. The non-transitory computer readable medium of claim **18**, wherein the method further comprises

providing a notification to respective listing user devices along a route leading to the event location.

20. The non-transitory computer readable medium of claim **18**, wherein the method further comprises obtaining, from a plurality of object detection sensors, status data sets associated with a plurality of listing locations, the status data sets being automatically generated by the plurality of object detection sensors based on one or more determinations that an object optically or acoustically obstructs one or more object detection sensors.

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